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A COMPARATIVE ANALYSIS ON PMMA AND PER FLUORINATED PLASTIC OPTIC FIBER IN ORIENTATION WITH ITS LOSS SPECTRUM

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ABSTRACT: ***The core part of this paper is to provide a comprehensive analysis and comparison of losses in polymethyl methacrylate (PMMA) fiber and per fluorinated multi-core polymer optical fiber. Manufacturer for plastic optic fiber out of plastic materials such as polystyrene, polycarbonates, PMMA,Which backs copper wires, co-axial cable, wireless, but it requires transmitter, receiver, connector alike glass optical fiber. These plastic optical fiber materials have transmission windows in the visible range (520-780-nm).coupling loss handicaps plastic optic communication against glass optical fiber which have losses of meager amount. Certain users find plastic optic communication benefits more than glass optical communication due to its greater flexibility, inexpensive test equipments, simpler and cost effective components. But the high coupling loss problem is being analyzed and brought down by per fluorinated Multi-core polymer material of 10 dB/km, which consists of 127 graded index cores the coupling loss of Multi-core polymer prototype is calculated based on measurements using MATLAB simulation for the geometrical, longitudinal, transverse and angular misalignment data has to be taken into account. Based on the simulation results the hints are listed in order to improve the production volume issue and to enhance the plastic optical fiber communication***

Keywords: ***PMMA, polystyrene, polycarbonates, per fluorinated Multi-core polymer***.

I. INTRODUCTION

When people hear of optical fibers, they immediately think of glass. Few people, including professionals in the business know about plastic optical fibers (POFs), which predate those made of glass. Because of its advantages it backs POF in the market. Today, a new enthusiasm permeates the plastics side of Optical fibers .The structure of the paper is as follows. First, profile and the characteristics of the PF MC-POF are analysed, in order to justify the use of the geometric ray-tracing method with this type of fiber. Different losses suffered by POF and PMMA. Then, the experimental set-up used to measure the coupling losses of PF MC-POFs is described. Then computer simulations of the coupling losses are presented and discussed, to be follow with some important considerations for the manufacturer in order to keep the losses as low as possible when connectors zing two MC POFs. Finally, we summarize the main conclusions.

II. PROFILE ABOUT PF MC-POF

A new type of MC-POF made of the per-fluorinated polymer called CYTOP® of 127 small GI cores with a cross-section of 350**µm** of diameter. In this sense, it is primary to know the various losses suffered by the MC-POF and PMMA, then its corresponding insertion loss of Connectors and its dependence on the three fundamental types of misalignments between fibers, namely, longitudinal separation, transverse offset and angular misalignment. In the case of MC-POFs, however, a fourth type of misalignment must be considered, namely the geometrical misalignment, which should be kept under the Control in order to minimize the coupling losses of these types of fibers. Among all, coupling loss plays the vital role in MC-POF due to the variation of the acceptance cone with the radial position. Unfortunately, to the best of our knowledge, there is no study for SI MC-POFs available in the literature, so it is not possible to assess the differences between PF MC-POFs and SI MC-POFs in terms of coupling losses.

III. POF DATA LINK

In its simplest form, a POF data link consists of a transmitter, receiver, cable, and connectors. The transmitters and receivers are electrical-to-optical and optical-to- electrical converters, respectively. More complicated data-link configurations include rings (each receiver on a network responds only to its address), Stars (signals go to a hub for relay), and meshes (all receivers are interconnected alike internet)

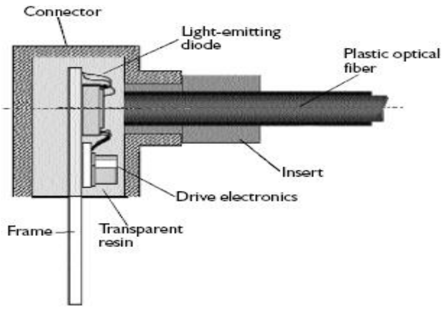

Fig.1 Connector and light source linked with POF

As when glass-fiber systems were introduced, simple point to- point POF links was installed first, followed by rings and stars there are two ways to characterize light transmission in a fiber classical ray tracing and the wave nature of light. A fiber consists of a core and cladding, with the core's index of refraction greater than that of the cladding. This reduces the diameter of the fiber that leads to lower dispersion and largest bandwidth. Most POFs have a uniform, or step, index of refraction that is the same across the width of the fiber, and step-index multimode fibers have the lowest bandwidth In a graded-index fiber, the index of refraction is highest at the center of the fiber and, thus, its profile has a parabolic shape. A graded-index fiber has a medium bandwidth.

Table.1 POF and glass optical fiber comparison

Parameters	Quantity	Unit
No. of cores	127	-
Core dia	25	µm
Cladding dia	350	µm
Area fractional	64.8	%
Numerical aperture	0.185	-
Attenuation	45	dB/km

IV. ANALYSIS OF MC-POF

127-core prototype PF MC-POC is analysed and its key specification are summarized. The cross section figures are taken to determine the geometrical arrangement. Fiber bandwidth can be increased by reducing the number of modes or by changing the index.

A.Description of light propagatin in MC-POF

From the above characteristics, it is determined whether each core has single-mode or multimode behaviour. For this purpose, calculation of the waveguide parameter or normalized frequency *V*, taken into account = **(2πρ/λ) NA,** Where **ρ** is the core radius, **λ** is the wavelength of the light in vacuum and *NA* stands for the maximum numerical aperture.

Table .2 Specifications on investigation

Parameters	Plastic	Glass
Component loss	Low	expensive
Loss	High-medium (short distance)	Medium-low (long distance)
Connections	Easy to connect	Hard to connect
Flexibility	Flexible	Brittle
Wavelength	Visible	Infrared
NA	High (0.7)	Low (0.2-0.3)
Bandwidth	High (15gbps)	Large (50 gbps)

B. Description of light propagatin in MC-POF

From the above characteristics, it is determined whether each core has single-mode or multimode behaviour. For this purpose, calculation of the waveguide parameter or normalized frequency *V*, taken into account **V = (2πρ/λ) NA,** Where **ρ** is the core radius, **λ** is the wavelength of the light in vacuum and *NA* stands for the maximum numerical aperture. **M≈ (g/g+2) (V^2/2),** Where the factor *g* is the so-called profile exponent. a higher number of modes inside each core. Here POF with distinct core diameter has given below

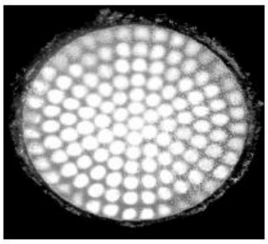

Fig.2 Cross section photograph of the surveyed PF MC-POF

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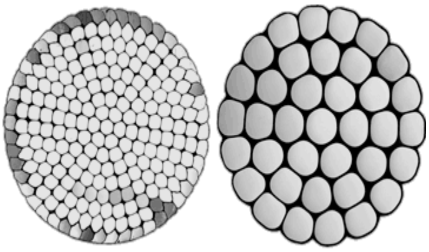
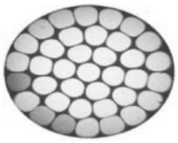
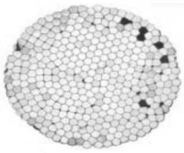


Fig .3 POF (1 mm fibers with 37 and 217 cores)

(A)



(B)O



(C)

(D)

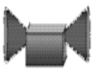
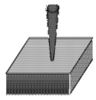
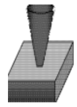
(E)

Fig .4
A-POF with 1024 µm core diameter
B-multi-core POF with 1024µm bundle diameter (39 cores)
C- multi-core GOF with 1000 µm bundle diameter (423 cores
D- PCS with 240 µm core diameter
E-GI-POF with 140 µm core

V. LIGHT SOURCES

LEDs (light emitting diodes) are large area emitting components, which are available at all wavelengths. Due to its large area, they cannot be modulated very fast. LEDs are low cost and simple to use. The combination with the SI-POF is nearly perfect. RC-LEDs (resonant cavity LEDs) are different from conventional LEDs due to the two additional Semiconductors Bragg mirrors above and below the light generation layer. LDs (conventional laser diodes) emit collimated light from the edge (edge emitters). They are available starting from 635 nm wavelength. Laser diodes are very fast, but they operate only until a given current (the so called threshold current), which is strongly with the temperature moreover, for the operation in data communication a power control is required, which makes the components more difficult. Vertical-Cavity-Surface-Emitting-Laser which is changing the light is collimated like for lasers (better fitted to the fiber NA). (VCSEL), so called surface emitters radiated like LEDs from the upper surface. There is a threshold current, but a very small one (typically a few milliamps). Data sheet for various LED's and LD are given below.

Tables.3 List the parameters of sources and its possible combination

Parameters	LED	LD	VCSEL	RCLED
				
λ	All	>630 nm	>660 nm	650 nm
I_{th}	-	40 mA	8mA	-
Typ.optical o/p power	2mW	7mW	1mW	2mW
Spectral width-nm	30	2	3	10
Emission angle[^{o}]	50	60 x 8	10	8
Emission areaµm^2	200 x 200	3 x 0.3	10 x 10	30 x 30
Remarks	Low cost	Requires 'I' ctrl	At 650 nm only for +50^{o}C	In lab for 520nm

Note that it can be extended this conclusion to the visible region of the electromagnetic spectrum, since it involves shorter wavelengths of light and, consequently, a higher number of modes inside each core. Therefore, it is also safe to apply the geometric optics approach in the case of the green LED discussed in the following section.

VI. EXPERIMENT

The receiving fiber is fixed perpendicularly to one of the two linear stages, whereas the transmitting fiber stands on a rotatory stage. The system is fully automated, and it allows the measurement of angular misalignments, longitudinal separations and transverse offsets, and geometrical misalignments. In all the measurements, the length of both the transmitting and receiving fibers was 2.5m.The measurements have been performed for the light source: (1) a green LED, and (2) a red laser diode

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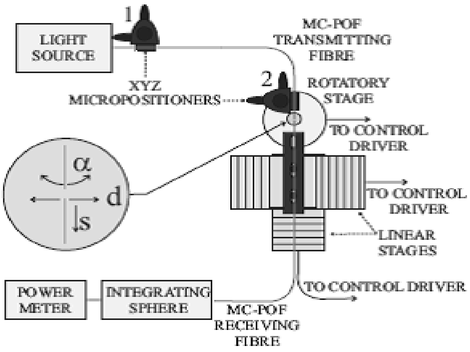

Fig.5 Experimental set-up to measure coupling losses of PF MC-POFs

(λ = 662.5 nm) and NA i/p = 0.038(pinhole = 2 mm), 0.11(pinhole =3 mm), or 0.25 (without pinhole). After these results it is concluded that the choice of the wavelength is not relevant in the analysis of coupling losses. In the case of the green LED, the spot size covers completely the input surface of the transmitting fiber, whereas in the other set-ups of the light source the laser spot size is much smaller than the fiber diameter. Both the spot size (2.55μm, 38.39μm) and the numerical aperture (0.25, 0.038) have been Measured from the near- and far-field patterns of the transmitting fiber by using the Hamamatsu LEPAS system .Therefore, for each of the light source configurations described above, the near- and far-fields of the transmitting fiber were measured by means of LEPAS system. After that, coupling loss against longitudinal separation measurements was taken for different polar angles of the transmitting fiber, The polar angle describes the angular orientation of the fiber with respect to a fixed reference direction defined in the plane perpendicular to the fiber axis Similarly, coupling loss against measurements of longitudinal separation were recorded for different transverse offsets. Next, coupling loss against measurements of transverse offset, angular misalignment was measured. The step size for each set of measurements was different: 50μm for longitudinal separation, 20μm for transverse offset, and 0.5^{o} for angular misalignments. Each measurement was repeated three times and the mean value was taken in order to obtain more accurate experimental results. For convenience, the results of coupling loss will be represented using each misalignment parameter normalized with respect to the radius of the Cladding

VII. RESULTS AND DISCUSSION

A. Near- and far-field patterns

Figures 6 show the experimental near- and far-field patterns measured at the output surface of the transmitting fiber for different launching conditions. Each near-field pattern represents the emission pattern of the corresponding light source filtered by the local numerical aperture of the MC-POF and modified by the crosstalk between adjacent cores. Figure 6 corresponds to the case of the green LED to the case of exciting the transmitting fiber with the three different numerical apertures.

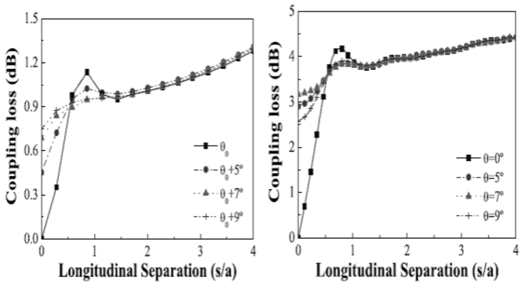

Fig.6 near and far-fields of the investigated PF MC-POF for a green led.

i) Experimental result ii) numerical result

B. Transverse offset

Next we show the results obtained for the coupling loss as a function of the normalized offset *d/a* for different longitudinal separations and source configurations. First of all, both in Fig.7 (green LED source)

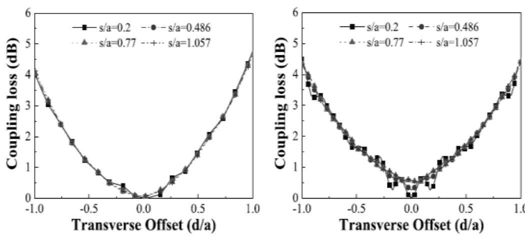

Fig.7 coupling loss against normalized transverse offset

C. *Angular misalignment*

Fig 8. Shows the experimental and numerical results of coupling losses as a function of the angular misalignment for the green LED.

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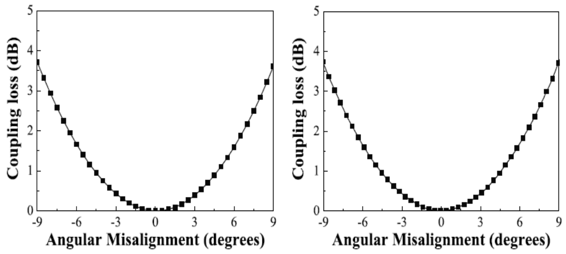

Fig.8 coupling loss against angular misalignment α (in degrees

In general, it can be concluded that the angular misalignment is not as critical as the transverse offset, provided that it is kept sufficiently small ($\alpha \leq 3^\circ$). Finally, it is important to remember again that coupling losses depend on the polar angle.

VIII.CONCLUSION

With the simulation findings it is inferred that, The core, cladding losses has to be reduced in MC-POF than in PMMA and It is essential to minimize the insertion loss found in transverse offset misalignment by altering the source configuration. Attenuation found in MC-POC to be brought down at slightest to 3-5db Core diameter to be maximized in PMMA in turn to access maximum of channels. On the whole both the POF's are meritorious in cost effectiveness, ease of connection and its flexibity.If the above stated inference is taken into account and if it is materialized then the POF can occupy predominated place in optical fiber communication

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Biography

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